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(54) Exhaust processor.

(57) An "in-line" exhaust processor includes a housing (12) having an inlet (20) for introducing a combustion product (21) from an engine and an outlet (24) for exhausting filtered or otherwise treated combustion product from the housing. A first substrate (26) is situated in a forward or upstream position within the housing (12) to filter combustion product (21a) introduced into the housing through the inlet (20). A second substrate (28) is situated in an adjacent rearward or downstream position within the housing (12) to filter combustion product (21) from at least two sources in the manner explained below. Each substrate (26, 28) includes a cellular structure having opposite inlet and outlet ends and a longitudinal axis. The housing (12) includes a first clam shell portion (16) and a complementary second clam shell portion (14) joined to the first clam shell portion to surround and hold the substrate pair (26, 28) in series. The exhaust processor further includes a bypass channel (56) for diverting a selected portion of the combustion product introduced into the housing through the housing inlet (20) to the second substrate (28).

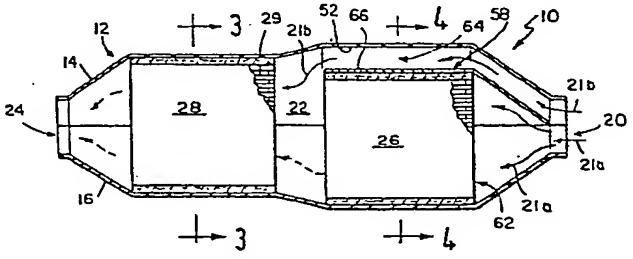

FIG. 1.

EP 0 318 462 A2

Description

EXHAUST PROCESSOR

This invention relates to exhaust processors usable to filter particulate matter from a contaminated fluid. More particularly, this invention relates to an "in-line" exhaust processor assembly including a processor housing and a pair of substrates mounted in series within the housing for solid particle filtration.

Conventional exhaust processors include a housing in communication with an exhaust manifold of an engine and a single monolithic substrate disposed therein to filter out noxious pollutants from the engine exhaust gases. However, in many cases a single substrate cannot provide a sufficient amount of filtering capacity. Typically, when more than one filter is needed, two substrates are mounted within a housing in a "side-by-side" or "spaced-apart parallel" relation. Hereinafter, such a conventional processor will be referred to as a "parallel processor."

Many types of parallel processors are known. One type includes a single inlet pipe that is coupled to two filters mounted in parallel by means of a "Y-design" three-way joint. A separate sheet metal housing having its own inlet and outlet ports is provided to house each of said filters. Another type includes a web-shaped common inlet cone that is coupled directly to two filters mounted in parallel. Each filter is provided with its own sheet metal housing. However, the web-shaped inlet cone is of sufficient size to contemporaneously engage the inlet ends of each of the parallel filters.

Manufacturers and users of exhaust processors such as catalytic converters and diesel particulate traps will appreciate the hardships and inconveniences generally associated with the design and installation of all types of conventional parallel processors. One problem relates to inadequate conservation of heat energy. For example, parallel exhaust processors comprising a pair of diesel particulate traps typically cause large quantities of heat energy to be wasted during "regeneration" of the traps. The filter elements or traps must periodically be cleaned to restore functionality thereto. Heat is applied to each trap to burn and oxidize the trapped carbon particles. In a diesel particulate trap of parallel construction, the heat energy required to "clean" each filter element must be conducted to the inlet face of each filter element by a pipe system. Thus, a complex, space-consuming, dual, heat delivery network of pipes and fixtures must be provided for each parallel "trap" processor. A large amount of the heat energy generated during such a regeneration burn is lost as waste exhaust heat that is discharged to the atmosphere. Another problem is that parallel processors are oftentimes not conveniently usable in confined spaces due to their large, unwieldy size and great bulk.

It is known to provide a processor housing having two substrates mounted in an "in-line" or "series" configuration rather than the parallel configuration described above in an attempt to avoid the shortcomings associated with conventional parallel processors. However known "in-line" processors have proven to be unsatisfactory substitutes for conventional parallel processors. One type of conventional inline processor is provided with a single, long, narrow substrate. It will be appreciated that it is best to construct a substrate using a ceramic material and that it is desirable, for purposes of strength, to keep the outside diameter to length ratio of a ceramic substrate as near to 1.0 as possible. A long narrow substrate is inherently characterized by an unacceptably high ratio and is quite fragile.

Another type of conventional in-line processor is provided with two shorter filters mounted in series within a single passageway in which all of the contaminated exhaust gas introduced into the housing is required to pass. It will be understood that one or both of these substrates can be prematurely clogged with particulate matter unless the "filter efficiency" of each of these in-line substrate filters is carefully "matched". Design and maintenance of this second type of conventional in-line processor is undesirably complicated by the need to install a less efficient filter in the forward or upstream position within the housing and a filter characterized by a higher efficiency in the rearward or downstream position within the housing. Selection of properly "matched" filters is an expensive and time consuming procedure.

Another type of in-line processor is disclosed in DE-A-2417435 and comprises a first annular substrate extending across the inlet of the processor housing and having a central unobstructed passage through which a portion of the exhaust gases pass direct from the inlet to a second substrate which is of less diameter than the housing to provide an annular passage for the gases which have been filtered by the first substrate to pass direct to the outlet. Each substrate thus filters a portion of the gas stream which has not been filtered by the other.

According to the present invention, an improved exhaust processor of "in-line construction comprising a housing including an inlet for introducing a combustion product into the housing and an outlet for exhausting combustion product from the housing, first and second substrate means for treating combustion product introduced into the housing through the inlet, and bypass means including a passageway between the outer boundary of the first substrate means and an interior wall of the housing, for distributing a portion of the combustion product introduced into the housing through the inlet to the second substrate means for treatment therein such that said distributed portion bypasses the first substrate means, is characterised in that said second substrate means is so positioned in the housing that all the combustion product exhausted from the first substrate means is constrained to pass through the second substrate means on its way to the housing outlet. Each substrate preferably includes a cellular structure having opposite inlet and outlet ends and a longitudinal axis. One advantage of

the processor is that both cellular structures can be of short length to minimize fragileness. Another advantage is that both cellular structures can have substantially equivalent filter efficiencies to reduce design complexity and cost. The pair of cellular structures are preferably positioned within the housing in end-to-end relation to be substantially coaxially aligned therein.

The housing is desirably of "clam Shell" construction although it is within the scope of the present invention to employ a "stuffed-can" construction. The housing preferably includes a first clam shell portion and a complementary second clam shell portion joined to the first clam shell portion to surround and hold the substrate pair in series.

Installation of the bypass means within an exhaust processor of in-line construction serves to allocate combustion product among the two substrates in substantially equal quantities. This feature advantageously permits installation of two substrates having substantially equivalent "filter efficiencies" since each deployed substrate is exposed to roughly the same volume of contaminated fluid or combustion product.

The "diverted" portion of the untreated combustion product is routed directly to the second or downstream substrate and thus entirely bypasses the first or upstream substrate. In addition, the remaining "undiverted" combustion product is routed directly to the first substrate.

According to a preferred embodiment of the present invention, the bypass means includes a partition member or internal shell that is installed in an upstream position extending along only about one-half of the housing to divide the axially forward portion of the housing interior into separate first and second passageways. The first substrate is desirably mounted in the first passageway in proximity to the housing inlet. Thus, the first passageway defines one path for conducting undiverted combustion product to the first substrate for treatment therein and for subsequent exhaustion to the second substrate for treatment therein prior to exhaustion from the housing. In addition, the second passageway defines another path for conducting diverted combustion product directly to the second substrate for treatment therein prior to exhaustion from the housing.

One feature of the present invention is the provision in an "in-line" exhaust processor of bypass means for diverting a selected quantity of untreated combustion product to the second substrate for treatment therein. This novel structure causes the flow of combustion product introduced into the processor to be split into substantially equivalent portions. In effect, one-half of the initially untreated combustion product is allocated and conducted to the first substrate for filtration therein, and the other one-half of the untreated combustion product is allocated and conducted to the second substrate for filtration therein. The present invention advantageously permits installation of two conventionally sized substrates having substantially equivalent filter efficiencies within a compact exhaust processor assembly of "in-line" construction.

In this specification and in the claims, the words "an exhaust processor" are intended to refer to various types of catalytic converters and processors, diesel particulate filters, and other particulate traps in connection with which the invention may be used.

The invention can best be understood by referring to the following description and accompanying drawings which illustrate preferred embodiments exemplifying the best mode of carying out the invention as presently perceived.

Fig. 1 is a view of a longitudinal cross section of an in-line exhaust processor incorporating one of the preferred embodiments of the present invention with portions broken away;

Fig 2 is an exploded view of the embodiment of Fig. 1 showing the clam shell housing and a single interior shell.

Fig. 3 is a view of a "downstream" transverse cross section of the embodiment shown in Fig. 1, taken along lines 3-3 of Fig. 1;

Fig 4 is a view of an "upstream" transverse cross section of the embodiment shown in Fig. 1, taken along lines 4-4 of Fig. 1;

Fig. 5 is a view of a longitudinal cross section of an in-line exhaust processor incorporating another of the preferred embodiments of the present invention with portions broken away;

Fig. 6 is an exploded view of the embodiement of Fig. 5 showing the clam shell housing and a pair of interior shells in confronting relation;

Fig. 7 is a view of a "downstream" transverse cross section of the embodiment shown in Fig. 5, taken along lines 7-7 of Fig. 5; and

Fig. 8 is a view of an "upstream" transverse cross section of the embodiment shown in Fig. 5, taken along lines 8-8 of Fig. 5.

An exhaust processor assembly 10 of the present invention includes a housing 12 of the clam shell type including an upper half shell 14 and a lower half shell 16. Shell halves 14, 16 are conventionally steel stampings. In final assembly, halves 14, 16 are welded or otherwise joined along shell flanges 18.

The housing 12 further includes a housing inlet 20 to receive a combusion product 21 of an engine (not shown) into a cavity 22 formed by the marriage of the upper and lower half shells 14, 16. Also, a housing outlet 24 is provided to exhaust combustion product from the housing 12.

First and second substrates 26 and 28, respectively, are disposed within the cavity 22 of the housing 12 in a manner to be described. Each substrate is a cylindrically-shaped monolithic cellular structure of conventional diameter and length. The substrate could be a structure having a large number of thin-walled passages 29 extending radially and longitudinally between the ends of the cellular structure.

It will be understood that the cellular structure could alternatively be of the type used in a diesel particulate trap without departing from the scope of the present invention. Further, the "filter efficiency" of each of substrates 26, 28 is substantially equivalent, in contradistinction to conventional in-

line exhaust processors which inherently must use two substrates having different "filter efficiencies". One significant advantage of the present invention is that a pair of substrates of conventional size and of similar efficiency are usable in a compact in-line exhaust processor.

In the embodiment of Figs. 1-4, the exhaust processor 10 includes a partition 58 in the form of an internal shell half 58 which includes an inlet cone section 32 and a first body section 34. Inlet cone section 32 operates to divert approximately one-half of the incoming combustion product 21 to the second substrate 28 so as to wholly bypass the first substrate 26. Internal shell half 58 includes peripheral flanges 60 so as to be rigidly fixable between shell halves 14 and 16.

The first and second substrates 26, 28 are positioned within housing 12 in end-to-end substantially coaxial relation in this embodiment by placing the first substrate 26 in a first passageway 62 between the internal shell half 58 and the lower shell half 16, and by placing the second substrate 28 between shell halves 14 and 16 as shown best in Fig. 1. The substrates 26, 28 are mounted in their proper positions using any conventional technique.

In the embodiment of Figs. 1 to 4, the second substrate 28 is exposed to the filtered combustion product 21a exhausted from the first substrate 26, in addition to the untreated combustion product 21b which is conducted to the second substrate 28 through a second passageway 64. This second passageway 64 is defined by inwardly facing surface 52 and the outwardly-facing surface 66 of internal shell half 58 and causes combustion product portion 21b to wholly bypass the first substrate 26.

In operation of the embodiment of Figs. 1 to 4, about one-half of the combustion product 21a is filtered by the first substrate 26 while the entire flow of combustion product 21a, 21b is intercepted and filtered by the second substrate 28. One advantage of this feature is that provision of the bypass means guarantees that the in-line exhaust processor of the present invention can continue to use two substantially similar substrates of the same filter efficiency. Another advantage of this feature is that it aids in conserving heat during incineration of trapped solid particles within the substrate. During regeneration of a particulate trap, heat energy waste will be significantly minimized since heat applied to the first substrate 26 will pass through said substrate 26 to aid in the regeneration of the axially adjacent second substrate 28 whereas in conventional processors the heat energy applied to the first substrate 26 is merely discharged to the atmosphere.

In the embodiment of the invention illustrated in Figs 5 to 8, those elements numbered identically with the embodiment of Figs 1-4 perform the same or similar functions. In the embodiment of Figs. 5 to 8 a companion internal shell half 68 is installed in the housing 12 in confronting relation to the internal shell half 58. Thus installed, second passageway 64 is divided into upper and lower components 70, 72 and is shaped to resemble an oblong annular ring as best shown in Figs.7 and 8, rather than the arcute crescent section(s) of the embodiment of Figs 1-4 shown in Figs. 3 and 4.

Thus, a dual bypass passage 70, 72 is provided around the first substrate 26. One effect of such a feature is that the lower bypass passage 72 and the upper bypass passage 70 each operate to conduct about one-quarter of the combustion product 21 introduced into the housing 12 through the housing inlet 20.

Claims

1. An exhaust processor assembly (10) comprising a housing (12) including an inlet (20) for introducing a combustion product (21) into the housing and an outlet (24) for exhausting combustion product from the housing, first and second substrate means (26, 28) for treating combustion product introduced into the housing through the inlet, and bypass means including a passageway between the outer boundary of the first substrate means (26) and an interior wall (52) of the housing, for distributing a portion (21b) of the combustion product introduced into the housing through the inlet to the second substrate means for treatment therein such that said distributed portion bypasses the first substrate means, characterised in that said second substrate means (28) is so positioned in the housing (12) that all the combustion product (21a) exhausted from the first substrate means (26) is constrained to pass through the second substrate means on its way to the housing outlet (24).

2. An exhaust processor assembly (10) comprising a housing (12) including an inlet (20) for introducing a combustion product (21) into the housing and an outlet (24) for exhausting combustion product from the housing, first substrate means (26) situated in a forward position within the housing, and having an outer boundary defining an interior region for receiving and treating combustion product (21a) introduced into the housing through the inlet, second substrate means (28), situated in a rearward position within the housing to lie adjacent to the first substrate means, for treating combustion product introduced into the housing through the inlet, and bypass means including a passageway between the outer boundary of the first substrate means (26) and an interior wall (52) of the housing, for diverting a portion (21b) of the combustion product introduced into the housing through the inlet, to the second substrate means for treatment therein such that said diverted portion bypasses the first substrate means and the remaining undiverted portion (21a) enters the first substrate means, whereby said diverted portion of the combustion product introduced into the housing is intercepted and treated by only the second substrate means prior to being exhausted from the housing through the hous-

ing outlet characterised in that said second substrate means (28) is so positioned in the housing (12) that all the combustion product (21a) exhausted from the first substrate means (26) is constrained to pass through the second substrate means on its way to the housing outlet (24).

3. The processor of claim 1 or 2, wherein the housing further includes a first clam shell portion (16) and a complementary second clam shell portion (14) joined to the first clam shell portion to surround the first and second substrate means (26, 28).

4. The processor of any one of claims 1 to 3, wherein the bypass means includes partition means (58) for dividing the interior of an axially forward portion of the housing (12) into a first passageway (62) for conducting the undiverted combustion product (21a) and a second passageway (64) for conducting the diverted combustion product (21b), the partition means being rigidly fixed to the housing to cause one mouth of each passageway to be in communication with the housing inlet (20) and the other mouth of each passageway to be in communication with the inlet end of the structure of the second substrate means (28) such that the undiverted combustion product conducted through the first passageway is sequentially introduced into the first and the second substrate means (26, 28) for treatment therein and the diverted combustion product conducted through the second passageway bypasses the first substrate means and is introduced only into the second substrate means for treatment therein.

5. The processor of claim 4, wherein the partition means (58) includes a shell half which includes a body section (34) for receiving a portion of the first substrate structure (26) therein and an inlet cone section (32) for conducting combustion product from the housing inlet (20) to the substrate structure received in the body section (34).

6. The processor of claim 5, wherein the shell half section (58) is formed to include a receptacle having an open mouth, and the shell half is rigidly fixed to the housing (12) to cause its mouth to open toward the first clam shell portion (16) and its inlet cone section (32) to be in communication with the housing inlet (20).

7. The processor of claim 5 or 6, further comprising first means for mounting the structure of the first substrate means (26) to the shell half (58) and to the first clam shell portion (16) to be suspended in the first passageway (62) and second means for mounting the structure of the second substrate means (28) to the first and second clam shell portions (16, 14) to be in communication with both of the first and second passageways (62, 64).

8. The processor of any one of claims 5 to 7, wherein the inlet cone section (32) of the shell half (58) includes forward edge means for interrupting the flow of combustion product introduced into the housing through the housing inlet (20) to segregate the undiverted and diverted portions (21a, 21b) of the combustion product, the forward edge means and the first clam shell portion (16) cooperate to define the inlet mouth of the first passageway (62) through which the undiverted combustion product (21a) is conducted, and the forward edge means and the second clam shell portion (14) cooperate to define the inlet mouth of the second passageway (64) through which the diverted combustion product (21b) is conducted.

9. The processor of any one of claims 1 to 3, wherein the bypass means includes a first shell half (58) and a complementary second shell half (68), each shell half including a body section (34) for receiving a portion of the first substrate structure (26) therein and an inlet cone section (32) for conducting combustion product from the housing inlet (20) to the substrate structure received therein.

10. The processor of claim 9, wherein each body section (34) is formed to include an open mouth, the first shell half (58) is rigidly fixed to the housing (12) to cause its mouth to open toward the first clam shell portion (16), the second shell half (68) is rigidly fixed to the housing (12) to cause its mouth to open toward its companion second clam shell portion (14) so that the two shell halves are held in confronting relation.

11. The processor of claim 10, further comprising first means for mounting the structure of the first substrate means (26) to the rigidly fixed shell halves (58, 68) to be suspended in the first passageway (70, 72) and second means for mounting the structure of the second substrate means (28) to the first and second clam shell portions (16, 14) to be in communication with both the first passageway (70, 72) and the outlet of the first substrate means (26).

12. The processor of any of claims 4 to 11, wherein the first clam shell portion (16) and the second clam shell portion (14) each includes a flange (18), the partition member (58, 68) includes a flange 60) and the flanges (18, 60) cooperate to define a single split line extending along the axially forward portion of the processor (10) between the housing inlet (20) and the outlet of the first substrate means (26).

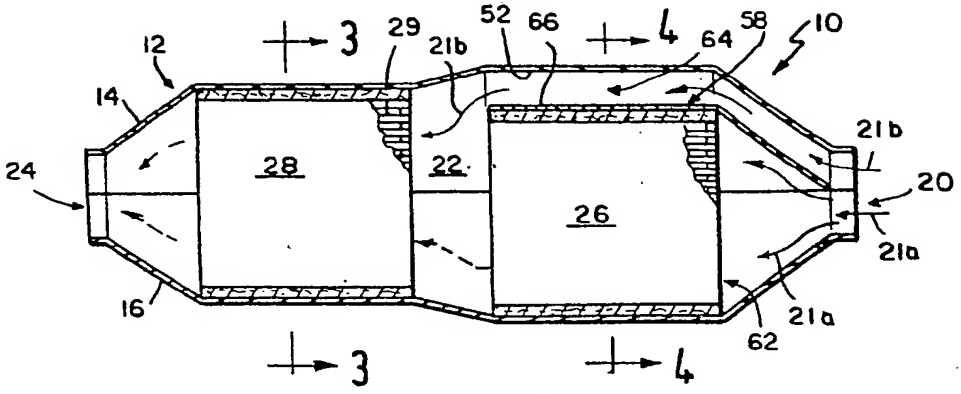

FIG. 1.

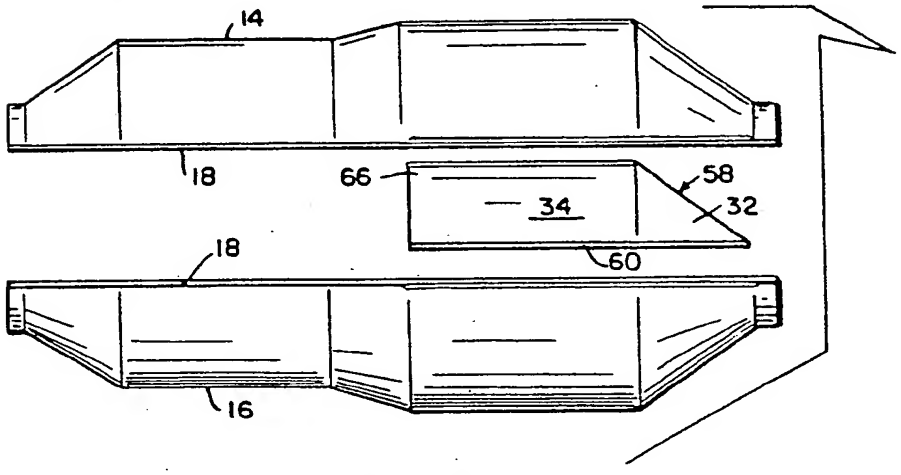

FIG. 2.

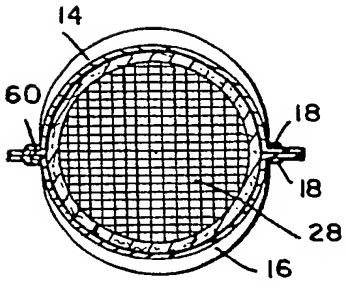

FIG. 3.

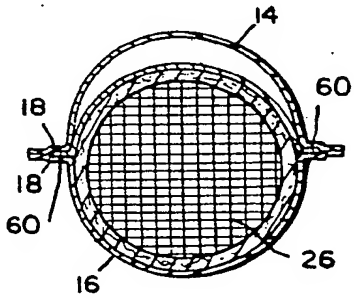

FIG. 4.

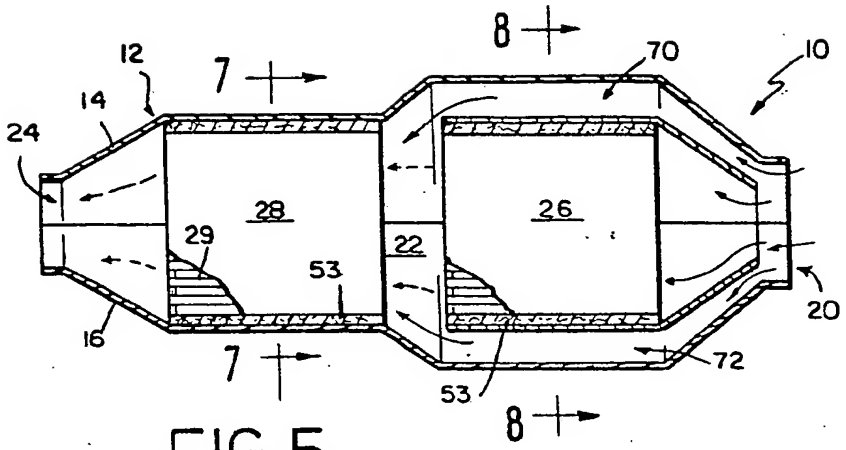

FIG.5.

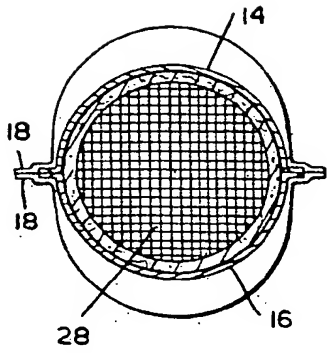

FIG. 7.

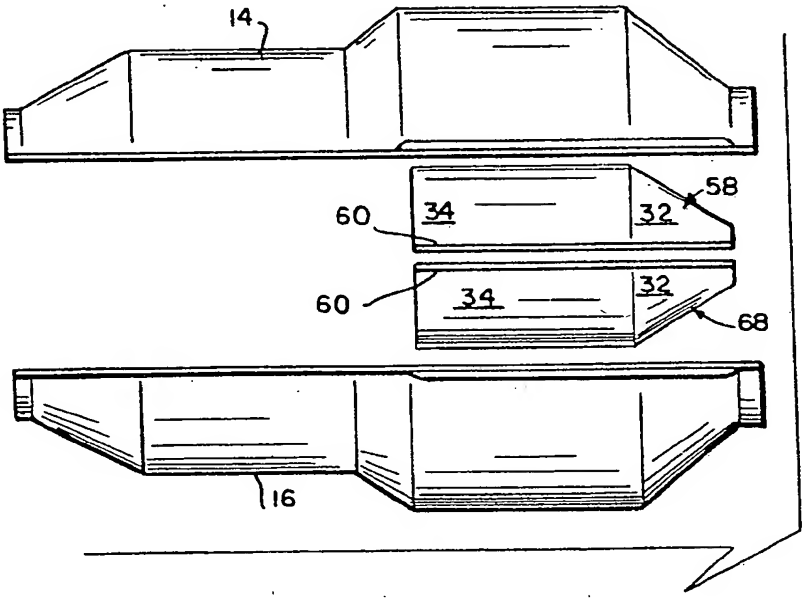

FIG. 6.

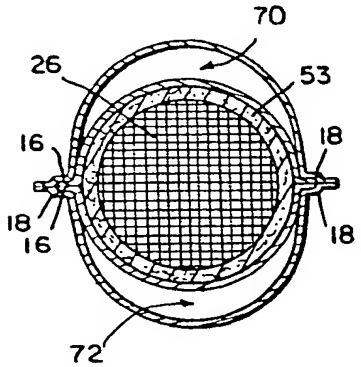

FIG. 8.

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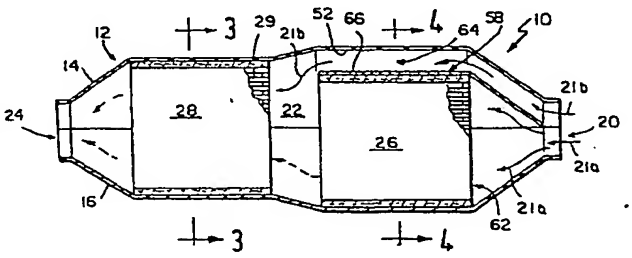

FIG. 1.

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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 10 0288

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-4 175 107 (IWAOKA) * Column 3, line 13 - column 4, line 23; figure 3 *	1	F 01 N 3/02 F 01 N 3/28
A	---	2,4	
D,A	DE-A-2 417 435 (DAIMLER-BENZ) * Page 4, line 12 - page 5, line 21; figures *	1,2	
A	---		
	US-A-3 879 944 (BERTSCH) * Column 1, line 33 - column 3, line 20; figure 1 *	1,2	
A	---		
	FR-A-1 257 056 (OXY-FRANCE) -----		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

F 01 N
B 01 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14-04-1989	HAKHVERDI M.

CATEGORY OF CITED DOCUMENTS

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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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